

Status of US Navy Ship Airwake CFD Efforts

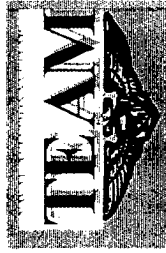
Dr. C. W. S. Bruner

Ms. S. A. Polsky

Dr. W. Tseng

20000407 143

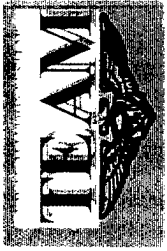
REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.					
1. REPORT DATE		2. REPORT TYPE Viewgraphs		3. DATES COVERED	
4. TITLE AND SUBTITLE Status of U.S. Navy Ship Airwake CFD Efforts				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Dr. C. W. S. Bruner, Ms. S. A. Polsky, Dr. W. Tseng				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Air Warfare Center Aircraft Division 22347 Cedar Point Road, Unit #6 Patuxent River, Maryland 20670-1161				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Naval Air Systems Command 47123 Buse Road Unit IPT Patuxent River, Maryland 20670-1547				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Christopher Bruner
Unclassified	Unclassified	Unclassified	Unclassified	16	19b. TELEPHONE NUMBER (include area code) (301) 342-8542



Outline



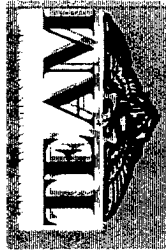
-
- Brief Review of Physics
 - The Ideal CFD Code Validation Experiment
 - Generic Frigate Results
 - LHA Results



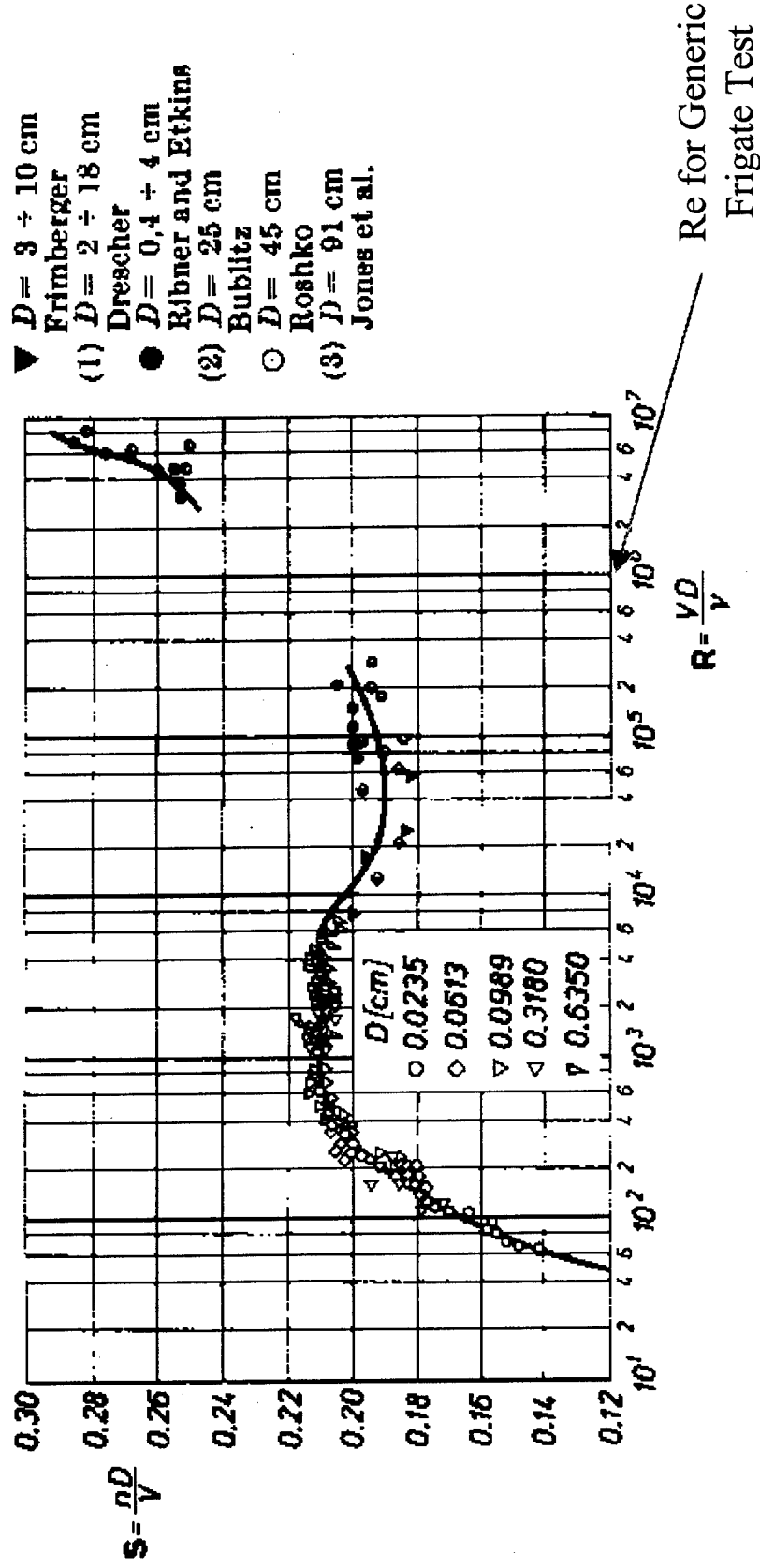
Simple Geometry, Complex Physics

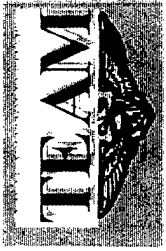


- Wake-dominated
- Strong Vortices
- Vortex Shedding
 - may be periodic, or not, depending on Reynolds number
- Data for full-scale Re is extremely hard to find (Bruce Johnson @ USNA?)



Schlichting Data for a Circular Cylinder





The Ideal CFD Code



Validation Experiment

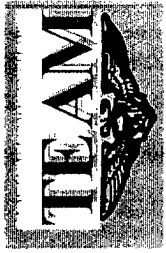
- Detailed Measurement of Boundary Conditions
 - inlet velocity profile
 - outlet pressure map
 - wall boundary layer measurements
- Redundant Data Measurements, e.g.,
 - LDV + pitot-static
 - taps + Kulites



Conclusions from Physics



-
- Experiments Should
 - include unsteady measurements
 - include off-body measurements

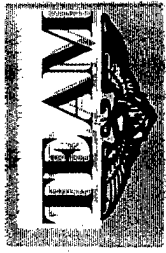


Ideal Validation



Experiment (cont.)

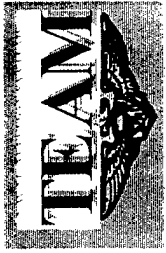
- Data Uncorrected for Wall, BL, Wake Effects
- Off-body Measurements



Pretty Good Validation Experiment



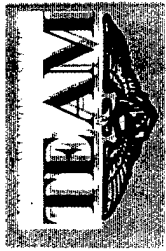
-
- NOT corrected for model or wake blockage
(we can run with walls)
 - Corrected for Tunnel Wall BL (so those
walls can be inviscid)
 - Some off-body data
 - Unsteady surface pressures



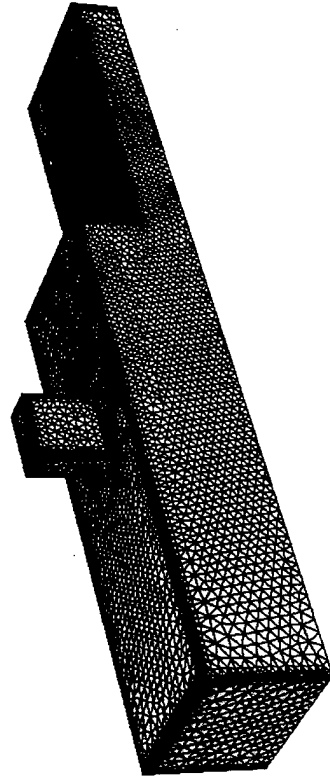
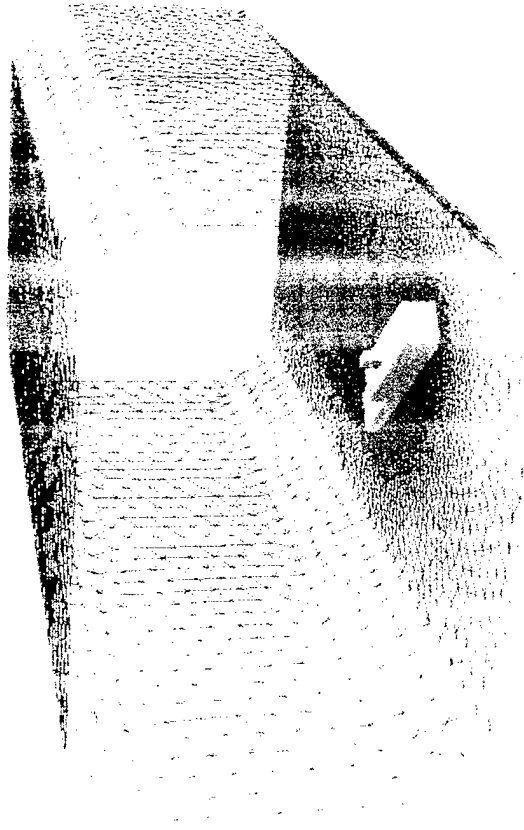
Generic Frigate Results

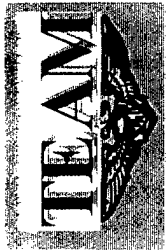


-
- Both structured and unstructured runs completed
 - in tunnel
 - free air
 - Concentrated on 45° case, but have some 0° results as well



Generic Frigate Grids

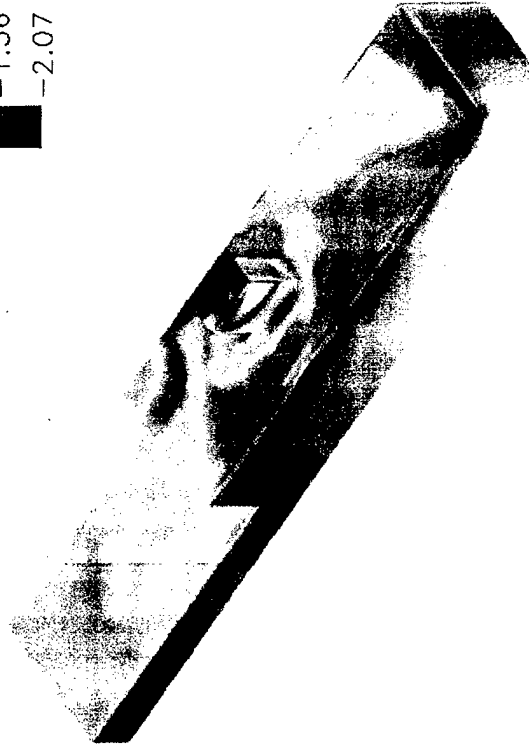




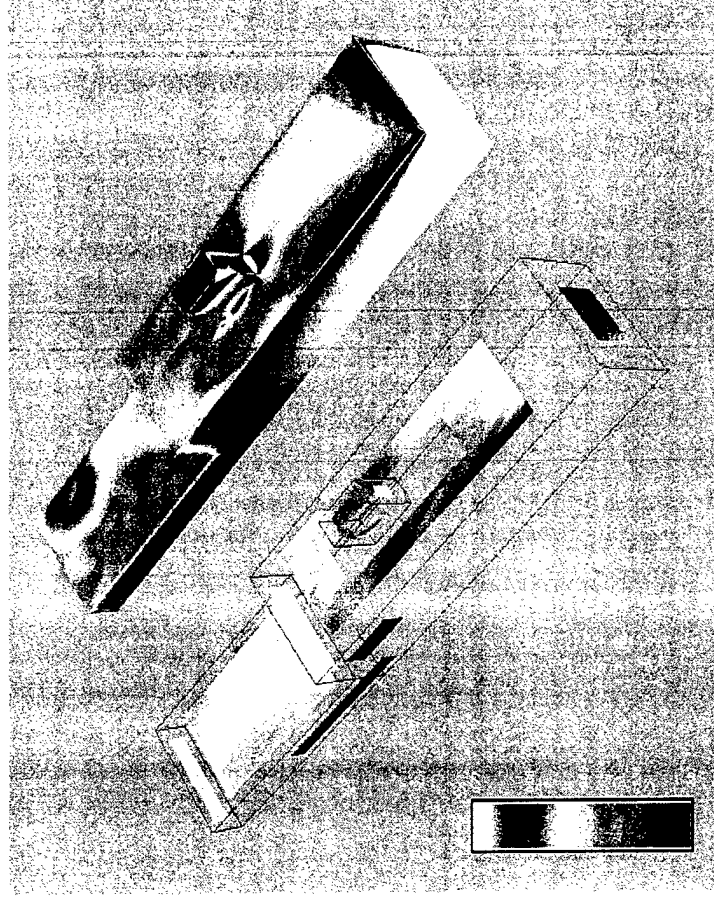
Generic Frigate Pressure Coefficient Contours



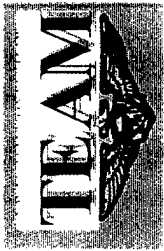
0.77
0.06
-0.65
-1.36
-2.07
Cp



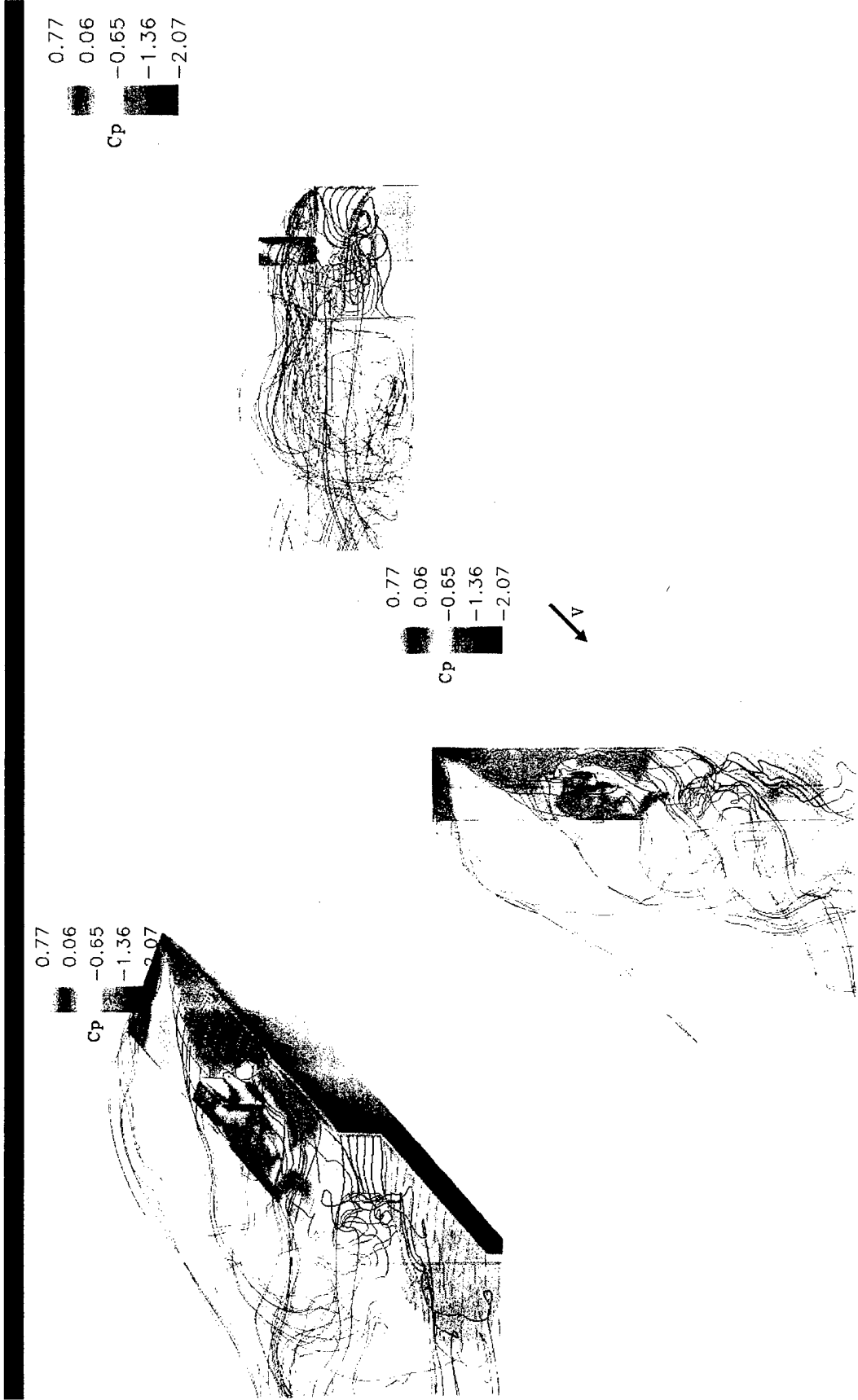
Unsteady laminar solution (snapshot)

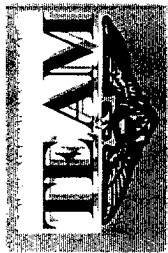


Steady laminar solution w/experimental data



Generic Frigate Streamlines





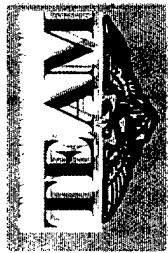
LHA Pressure Coefficient Contours



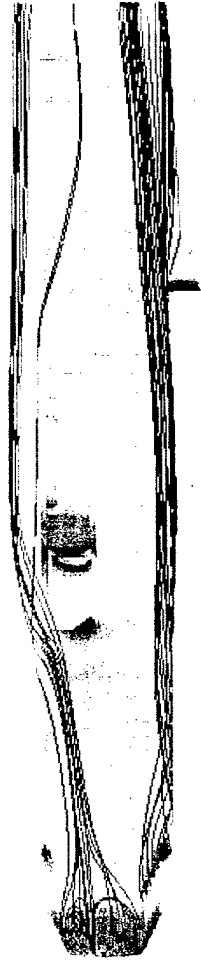
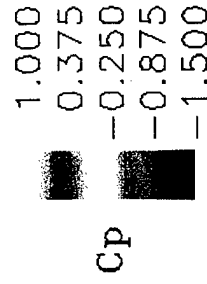
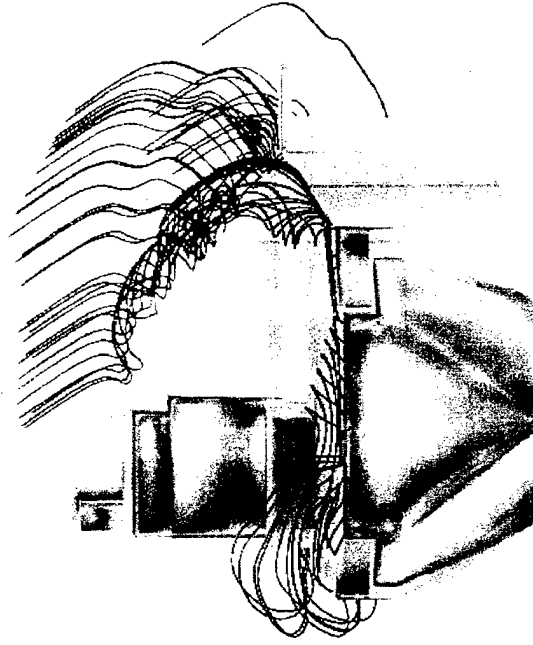
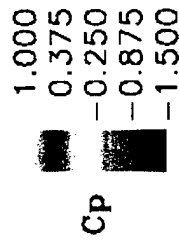
1.000
0.375
-0.250
-0.875
-1.500
Cp

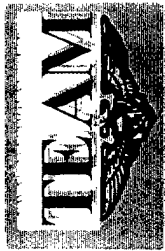
1.000
0.375
-0.250
-0.875
-1.500
Cp





LHA Streamlines



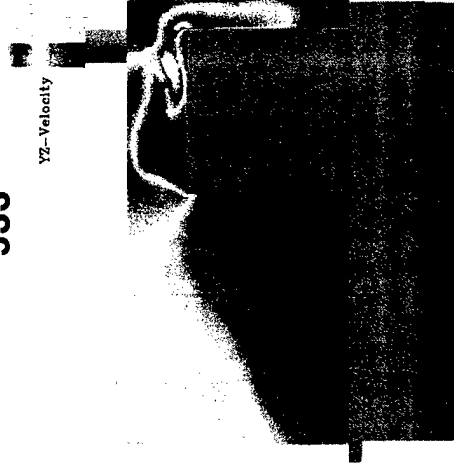


LHA Crossflow Velocity Countours



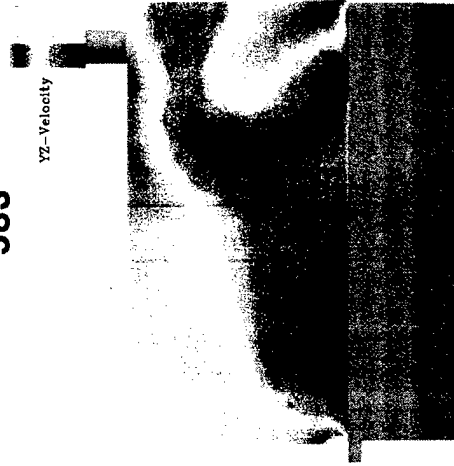
533'

YZ-Velocity



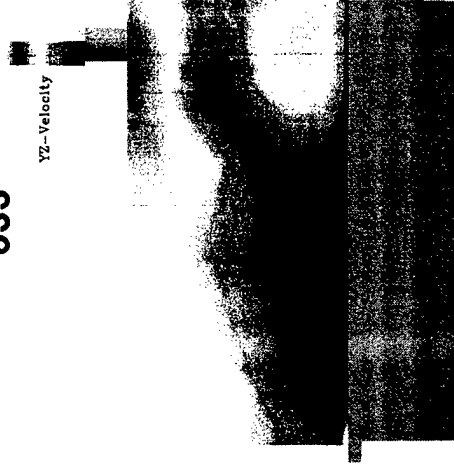
583'

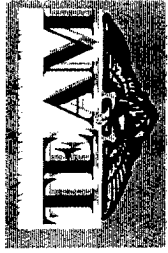
YZ-Velocity



633'

YZ-Velocity





Conclusions



-
- Unsteady computations are necessary to capture flow physics
 - flow is inherently unsteady
 - Rotor modeling critical to computing hover flight conditions
 - crossflow velocities much smaller than rotor downwash, but a LOT of fluid is affected
 - Full-scale Reynolds number testing is needed